CLAIMS

1. A machine comprising:

a support structure;

an element movable with respect to said support structure;

at least one guideway disposed on one of said support structure and said movable element along which said movable element and said support structure move relative to one another in a direction of travel, said one guideway having a coefficient of thermal expansion different from a coefficient of thermal expansion of said one of said support structure and said movable element; and

at least one member disposed on said one of said support structure and said movable element generally opposite from said one guideway, said member being generally parallel to said one guideway and having a coefficient of thermal expansion, a stiffness, a spacing from a center of mass of said one of said support structure and said movable element, and a cross-sectional dimension such that said member substantially balances any thermal stresses created by differential expansion and contraction of said one guideway and said one of said support structure and said movable element for a given change in temperature.

2. The machine as recited in claim 1, wherein said one member has a same coefficient of thermal expansion as said one guideway.

3. The machine as recited in claim 2, wherein said one member has substantially the same cross-sectional dimension and length as said one guideway.

4. The machine as recited in claim 1, further comprising a second member and a second guideway, and wherein said one member is disposed generally opposite said one guideway, and said second member is disposed generally opposite said second guideway.

5. The machine as recited in claim 1, wherein said one guideway is disposed on one surface of said support structure and wherein said one member is disposed on a second surface of said support structure that is aligned generally perpendicular to said one surface.

6. The machine as recited in claim 1, wherein said one guideway is disposed on one surface of said support structure and wherein said one member is disposed on a second surface of said support structure that is aligned generally parallel to said one surface.

7. The machine as recited in claim 1, wherein said one member is formed of the same material as said one guideway, wherein said one member has substantially the same cross-sectional dimension as said one guideway, wherein said one member has substantially the same stiffness as said one guideway and wherein said one member is spaced about a same distance from a center of mass of said one of said support structure and said movable element as said one guideway.

8. The machine as recited in claim 1, wherein said one member is affixed by an epoxy.

9. The machine as recited in claim 1, wherein said one member is affixed by screws.

10. The machine as recited in claim 1, wherein said one member is disposed on a side of the center of mass of said one of said support structure and said movable element opposite a side of the center of mass of said one of said support structure and said movable element on which said one guideway is disposed.

11. The machine as recited in claim 1, wherein said machine is a coordinate measuring machine and said support structure is a beam movable in one

direction, and said movable element is a carriage carrying a Z ram and movable in a second direction orthogonal to the one direction and wherein said one member and said one guideway are mounted on the beam.

12. The machine as recited in claim 1, wherein said machine is a coordinate measuring machine, wherein said movable element is a Z ram movable in a vertical direction, wherein said support structure is a carriage, and wherein said one guideway and said one member are mounted on said Z ram.

13. A coordinate measuring machine comprising:

an elongated beam movable in one direction generally perpendicular to its direction of elongation;

at least one rail disposed on said beam and extending in a direction generally parallel to the direction of elongation of said beam, said rail being formed of a material having a coefficient of thermal expansion different from a coefficient of thermal expansion of a material of said beam;

a carriage movable along said rail in the direction of elongation of said beam; and

a bar disposed on said beam generally on an opposite side of a center of mass of said beam from said rail, said bar having a coefficient of thermal expansion, a cross-sectional dimension, a stiffness and a spacing from the center of mass of the beam such that said bar substantially balances any thermal stresses on said beam produced by differential expansion or contraction of said beam and said rail with changes in temperature.

14. A coordinate measuring machine comprising:

a carriage movable along a beam in a first direction;

a ram movable with respect to said carriage in a second direction generally orthogonal to said first direction, said ram having a rail extending in the second direction disposed on one side thereof along which said ram travels

with respect to said carriage, said rail having a coefficient of thermal expansion different from a coefficient of thermal expansion of said ram; and

a bar extending generally parallel to said rail and disposed on a side of said ram generally opposite of said one side and on a generally opposite side of a center of mass of said ram from said rail, said bar having a coefficient of thermal expansion, a cross-sectional dimension, a stiffness and a spacing from the center of mass of said ram such that said bar substantially balances any thermal stresses on said ram produced by differential expansion or contraction of said ram and said rail with changes in temperature.

15. A coordinate measuring machine comprising:

an element movable in a first direction;

a rail along which said element travels, said rail extending in a said first direction;

a support structure on which said rail is mounted and having a center of mass;

a member disposed in said support structure on a side of the center of mass thereof opposite said rail, said member having a coefficient of thermal expansion, a cross-sectional dimension, a stiffness and a spacing from the center of mass of said support structure such that said member substantially balances any thermal stresses on said support structure produced by differential expansion or contraction of said support structure and said rail with changes in temperature.

16. A machine comprising:

a beam movable in a first direction along a rail assembly;

a slide coupled to said rail assembly which permits said beam to travel along said rail assembly in said first direction;

a slot disposed on said slide that is elongated in a direction generally perpendicular to said first direction; and

a pin affixed to said beam and extending into said slot, whereby any expansion or contraction of said beam in a direction perpendicular to said first direction causes said pin to move in said slot in the direction perpendicular to said first direction.

17. A machine comprising:

a beam;

two generally parallel rails disposed on said beam, said rails extending in a first direction;

a carriage movable along said rails in said first direction;

slides associated with each of said rails for permitting said carriage to move along said rails; and

a flexible coupling between said carriage and at least one of said slides to permit said carriage to move with respect to said at least one slide in a second direction generally perpendicular to said first direction.

18. The machine as recited in claim 17, wherein said carriage is supported by said coupling in a spaced relationship with said at least one slide.

19. The machine as recited in claim 17, wherein said coupling allows movement of said carriage in said second direction with respect to said at least one slide, but is sufficiently rigid in a direction perpendicular to both said second direction and said first direction to maintain said carriage in a spaced relationship with said at least one slide.

20. The machine as recited in claim 17, wherein said coupling is a leaf spring.

21. The machine as recited in claim 17, wherein said machine is a coordinate measuring machine.

22. A method of balancing thermal stresses on a beam having a rail along which an element moves with respect to the beam, the rail and the beam having different coefficients of thermal expansion, said method comprising:

determining a center of mass of the beam;

mounting a member on the beam on a side of the center of mass of the beam opposite from a side of the center mass of the beam on which the rail is disposed, the member being mounted such that it extends generally parallel to the rail; and

selecting a material and size and stiffness for the member such that a coefficient of thermal expansion of the member, a stiffness of the member, a cross-sectional area of the member and a spacing of the member from the center of mass of the beam causes the member to substantially balance thermal stresses in the beam produced by differential expansion or contraction of the beam with respect to the rail with changes in temperature.

23. The method as recited in claim 22, wherein the member is mounted on the beam at a distance from the center of mass of the beam which equals a distance from the center of mass to the rail, and wherein the coefficient of thermal expansion of the member, the stiffness of the member, and the cross-sectional area of the member are generally all equal to the respective coefficient of thermal expansion, stiffness and cross-sectional area of the rail.

24. A method of minimizing any bending of a beam in a coordinate measuring machine having a rail thereon, the rail and the beam having different coefficients of thermal expansion, the method comprising:

determining a center of mass of the beam;

placing a bar on the beam on a side of the center of mass of the beam opposite a side of the center of mass of the beam on which the rail is disposed;

aligning the bar in a direction generally parallel to the rail; and

selecting a cross-sectional area of the bar, a material for the bar having a coefficient of thermal expansion, a spacing of the bar from the center of

mass of the beam and a stiffness for the member such that any thermal stresses produced in the beam by the rail as a result of changes of temperature are generally equal to the thermal stresses produced in the beam by the member.

25. The method as recited in claim 24, wherein said placing step comprises affixing the bar to the beam such that the bar cannot move with respect to the beam.

26. The method as recited in claim 24, wherein said selecting step comprises selecting a coefficient of thermal expansion, a stiffness, a spacing from the center of mass of the beam and a cross-sectional area for the bar to be the same as a corresponding coefficient of thermal expansion, stiffness, spacing from the center of mass of the beam, and cross-sectional area of the rail.